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A Commentary on Various MRCP Photographing Techniques – Their Features and Depiction Ability

FASE (Fast Advanced Spin Echo) Technique

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Introduction

Because of the remarkable progress in MRI, starting with the SE (Spin Echo) technique, new photographic techniques, such as the MR angio and various high speed photography techniques etc., have been applied successively in clinical fields. In particular, the FASE technique is introduced here because it is the basis for MRCP (MR Cholangio Pancreatography).

I. What is the FASE technique?

The FASE technique is a high speed SE technique that photographs with single shots [6]. It can also be referred to as an RF refocus EPI (Echo Planner Imaging) technique. It can be thought of as a counter-electrode positioned photographic technique and a single shot EPI technique, of the type that started the practical application of head function imaging etc. in recent years. The simple principles are described below, but the single shot EPI technique collects the echo for one slice using high speed reversal of the gradient magnetic field, whereas the FASE technique collects echoes using illumination by an RF pulse of the desired frequency. Thus, even for the same single shot, it can be said that there is a very strong advantage with regard to magnetic susceptibility artifacts compared to the former technique, and a resolution much better than the single shot EPI technique can be obtained (Table 1). Also because the photography time is 1 to 2 seconds per slice, very short compared to the high speed SE technique, it is easy to

photograph in a respiratory arrest condition and, in examining portions of the abdomen, there are no artifact affects from the motion of breathing and clear high resolution images can be obtained 11)

In particular for photographic conditions TR = 3000 to 10000 and TE = 250, display can be done using the high signal, weighting the long T2 value of water, tumors, etc. This ability to obtain high resolution T2-weighted images in a short time is made good use of in MRCP. A fat control pulse and/or IR pulse are included to control the signal from fat, which can hinder observation.

Table 1 Comparison of FASE technique and other modalities

	High speed SE	FASE	Single shot EPI
Photographic time (for 1 slice • 128 matrix)	Around 10 seconds	Around 1 second	Less than 1 second
Resolution (maximum matrix with single shots)	- (can't be used)	High (512)	Low (256)
Artifacts • Susceptibility • Chemical Sift	 Fewest Fewest	 Few Few	 Many Many
Clinical applications	T1W1 • T2W1 • FLAIR • STIR • Fat control etc.	SAS • MRCP • MRUro. • MRCisterno. • MRVesico. • MRMyero. Etc.	f-MRI Diffusion / Perfusion

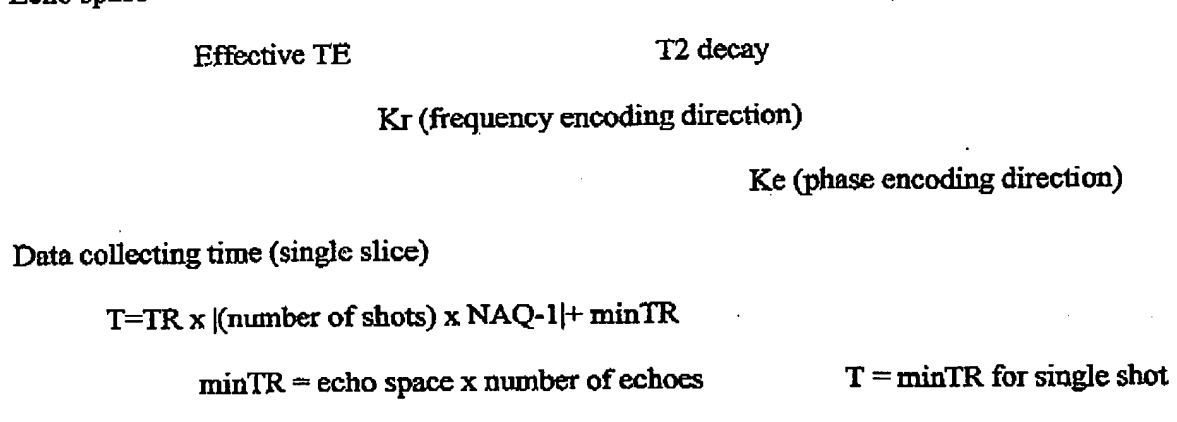

Figure 1 FASE Sequence Chart and k Space Trajectory

Figure 2 FASE Data Collection Sequence and k Space Trajectory Based on the Number of Shots

II. FASE Technique Principle

For each slice selection pulse, the high speed SE technique continuously adds RF pulses and collects multiple echoes. Using simple calculations, the SE technique can reduce the photography time by 1 over the number of echoes. Further, the FASE technique collects all necessary echoes using each slice selection pulse (Figure 1). In addition, by applying AFI (Asymmetric Fourier Imaging), the contrast ETL (Echo Train Length to k space center) and the effective TE can be stabilized independent of the number of the PE matrix, so it is possible to obtain the same image contrast regardless of whether the resolution is high or low. Also, the total data collection time is again reduced to around one half. The features that can be photographed with a single shot are the same as for the EPI technique but, depending on use of a gradient magnetic field or RF pulse illumination, the echo collection characteristics are as described above (Table 1).

Further, when collecting data based on multiple shots, because TE changes near the k space center are controlled (refer to the image contrast data in Figure 2) while the effective TE is kept fixed, it is possible to improve the image contrast and image blurring due to T2 relaxation[12].

III. 2D-FASE • 3D FASE Techniques and Their Clinical Applications

1. Differences from MRCP photographing

The FASE technique can make 2D • 3D photographs and is already used in many clinical fields. Various features in MRCP photographing [1-3] are described below.

a. 2D-FASE technique

Currently this is the most general technique used. Depending on the conditions, sometimes it is used for photographing a single slice in a short time and sometimes for

Photo 1 MRCP (taken with 3D-FASE technique) (Tokyo Women's Medical College Hospital Symptom example)

C B A C A B MRP image	MIP image
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ Original image	①+②+③+④ Added image

Photo 2 MRMyerography (hernia of the lumbar vertebrae intervertabral disc) (Jōsai Clinic Symptom example)

In the original images (1.5 mm thick component) taken with the 3D-FASE technique, the condition (nerve pressed against the protruding hernia) is clearly depicted and the MIP images show the whole spinal cord space. With the 2D-FASE technique, images similar to myelographs can be obtained in seconds.

3D-FASE technique MIP image	3D-FASE technique Original image
2D-FASE technique	T2 emphasized image

Photo 3 MR Cisternography (Jōsai Clinic Normal example)

For the 3D-FASE technique, the MPR and MIP were performed after the horizontal cross image was taken.

The MPR images were obtained from data taken with 3D photography in the horizontal cross section using the resolution (0.6 mm) along the slice direction with polar section conversion. Not only can the left and right nerves be simultaneously depicted but also motion of the blood vessel can be observed. The MIP image depicts shapes such as semicircular canals, snails, etc. Previously about 20 minutes were needed to photograph using a 3D-high speed SE technique, but with the 3D-FASE technique it can be accomplished in several minutes.

MPR image
MPR image
MIP image

Photo 4 Super FASE

<table>
<tr><td rowspan="2">Super FASE
T2W1</td><td>High speed SET1W1</td><td>High speed SET2W1</td></tr>
<tr><td>Super FASE T1W1</td><td>Super FASE T2W1</td></tr>
<tr><td>FBI</td><td colspan="2">Super FASE
T2W1</td></tr>
</table>

photographing multiple slices over several tens of seconds. In either case the following advantages are present.

1) High resolution images can be obtained in a short time: Because slice architecture is completed for a single respiratory arrest, no position shift occurs due to the effects of breathing (for single shot • single slice photography, only about 2 seconds even when a 384 x 384 matrix is made).
2) Wide selection range for slice thickness: Photographs are made based on the objective, such as capturing a whole image of the pancreas • bile duct system (thick slice: about 50 mm), or observing the state • position of cholecystolithiasis • common bile duct stones (thin slice: equal to or less than 10 mm).

b. 3D-FASE technique

The biggest advantage of the FASE technique is that it can make 3D photographs. The following describe its features.

1) Detailed structures can be observed using the resolution in the slice encoding direction: Cystic ducts and pancreatic ducts etc. can be depicted. In particular, valuable information describing cholecystis and common bile duct stones, etc. in the original images is included (Photo 1 bottom left).
2) Images from arbitrary directions can be obtained using the MIP process (maximum projection): Complicatedly twisted junctions of cystic ducts and common hepatic ducts etc. can be imaged. However, because only those with high signals are projected, stones etc. with low signals cannot be identified regardless of their size (Photo 1 top right).
3) Arbitrary cross sections can be imaged with an MPR (cross section conversion) process: It is possible to identify stone locations from other cross sections (Photo 1 top left).

4) It is possible to use added images to produce a whole image while keeping the original image information: In an image (Photo 1 bottom right) obtained by selectively adding only four slices of the original image, very small stones, that cannot be observed using MIP images, can also be depicted.

As described above, 3D photography can obtain supplementary information (that cannot be obtained with 2D photography) by adding processed images based on the conditions during the original and MIP image observations.

2. Application to other positions

The FASE technique uses the advantages already described (Table 1) and is applied in various body positions. Below some photography techniques that are applied in practical clinical fields will be introduced.

a. SAS (Surface Anatomy Scan)

This reverses the cerebrospinal fluid signal and shows three dimensional images of gyri cerebri and sulci cerebri [19]. Position relationships of pathological changes in [translators note: unfamiliar term – possibly frontal lobe?] can be determined in only a few seconds.

b. MR Cisternography

This is depicted by using the cerebrospinal fluid signal and separating the cerebral nerves and the parallel blood vessels. Information (that cannot be obtained with other modalities [4,7]) can be imaged using added images and/or MPR images (Photo 3).

c. MR Myerography

In this technique information about intervertebral discs and cauda equina nerves etc. is obtained indirectly from depiction of the spinal fluid high signal (Photo 2). For both 2D and 3D

photography, without using angiographic agents, an image the same as a myerograph can be non-invasively obtained.

d. MR Urography and MR Vesicography

MR Urography [5] and MR Vesicography [17] are techniques that use the urine signal to make images of the urethra system, compared to MRCP which has bile and pancreatic fluid as targets. The former targets the cystectasia and has mostly the same procedures as MRCP. For the latter 3D photography is necessary to depict small pathological changes inside the bladder.

Therefore, 3D-FASE photography can be applied to every position and there is no end to its possibilities. Next, further developments in FASE techniques will be described.

IV. FASE Technique Development

1. Entrance of the Super FASE Technique

Recently, accompanying an emphasis on hard surfaces, the FASE technique has accomplished new developments. Additional selections for the effective TE and total data collection time are available by adding echo spaces shorter than various previous echo spaces. This not only makes clear contours of the biliary system and pancreatic ducts with MRCP but also ensures that organs with motions and organs which have small T2 values can be depicted (Photo 4). This is referred as the Super FASE technique.

2. Super FASE Technique Applications

For this newly studied photography, the following blood flow images can be given. With use of these photography techniques, it is possible to simultaneously depict MRCP images and blood vessels.

a. FBI (Fresh Blood Imaging) [14]

Images of the abdominal aorta etc., that were impossible to depict using previous FASE techniques due to the high speed flow, can be made without using angiographic agents. Compared to the PS (Phase Shift) technique, high resolution photography can be performed in a very short time (Photo 4 bottom left).

b. SPEED (Swap Phase Encode Extended Data) [9, 15]

This technique is a further development based on the FBI. It collects two data at once in the phase encode direction and obtains MRA images without blurring. By using the resolution, expansion in multiple directions, for application to the photography of pulmonary and abdominal blood vessels, is possible.

Other various photography techniques such as Diffusion FASE [13], PS FASE, and myocardium depiction etc. are being studied and further possibilities can be expected.

Conclusion

The FASE technique, a representative of the MRCP, has already been applied to every position and continues to be developed as a third generation SE technique. In the future, by including the Super FASE technique, it can be expected to be a very helpful technique in new clinical applications.

References

2) Ohgi, K. et al: Applications of MRCP using super T2 weighted images (FASE and HASTE) - Including O2 absorption and compression images. 56th Japan Medical Radiation Conference General Meeting, April, 1997, Yokohama.

3) Ohgi, K. et al: MRCP based on FASE, HASTE, and RARE - Including recent new information. Film information medical (additional issue), 28: 115-120, 1997.

7) Tanaka, S. et al: Evaluation of Neurovascular Cross Compression with MR Cisternography - Including comparison of various image processes centered on 3D super high speed T2 weighted images (FASE). Japan Philanthropic Medical Journal, 17(S): 265, 1997.

10) Ohgi, K. et al: The clinical applications and possibilities of spin echo super high speed photography. Cutting edge medical technology, 4(6): 1997.

11) Machida, Y. et al: New development of the FASE technique. Cutting edge medical technology, 4(6): 1997.

12) Katsunishi, Y.: Fast ASE and its clinical applications. Medical Review 22(2): 1998.